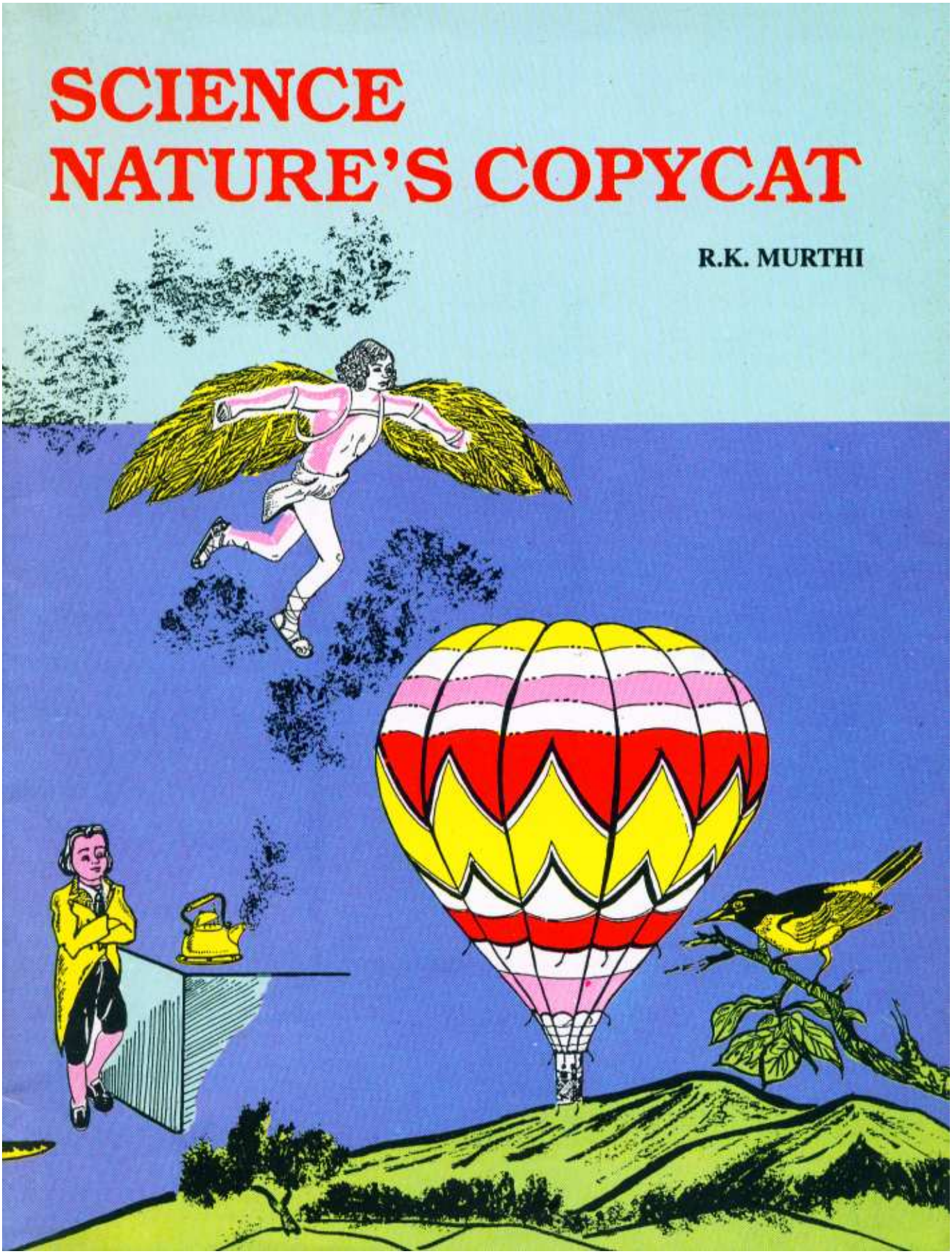
SCIENCE
NATURE'S COPYCAT

R.K. MURTHI



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PREFACE

Nearly four decades ago, I started my professional life as a lecturer. How could I succeed in my profession? A colleague simply said, "Make learning fun. Take the students along the fun-way to knowledge."

That became the key to my approach to young minds. It stood me in good stead when I took to writing for the young. The present book is all about how science takes the cue from nature. Now, does that make Science a copycat ?

Science is ever probing nature. That is its mission; that is its quest. The quest leads science to the secrets of nature. Science picks up from nature and adapts her laws to many an invention.

Science makes no secret of its debt to nature. It owes much to nature. For, nature indeed is the storehouse of all knowledge. What nature knows, science finds out and learns. Science finds nothing wrong in being a copycat.

I would like to express my deep appreciation for the illustrations provided by Ms. Seema Pandey for the book.

R.K. Murthi

To

Ramesh

My nephew for whom knowledge means power.

SCIENCE: NATURE'S COPYCAT

IT IS A fine winter afternoon of Sunday.

After a friendly cricket match, I return home. I run into the bedroom and find my sister, Lata, trying out very strange steps. Every time she moves, her eyes are on the full-length mirror in the bedroom.

"Gone mad?" I tease her, while she gambols like a deer. "No. I have been selected to play the role of *Marich* in a dance drama *Sita Apaharan* (Kidnapping of Sita by Ravana).The director said I must be lithe and graceful in order to play the role well. You know *Marich* changes into a golden deer," Lata bounces, her head bent a bit, and judges her success by the movements of her reflection in the mirror.

"So you are a copycat," I snipe. "Don't be afraid of being a copycat," we hear a soft, friendly voice and turn.

Our cousin, Nanu, who has just completed his studies and joined a national research centre as a scientist, stands framed against the door. We run to him. He warmly hugs us and asks, "Enjoying the holiday?"

"When did you come, Bhaiyya," we greet him. "Just now. Lata, let me see how you copy the movements of the gazelle," Nanu prompts her.

"You are encouraging her to be a copycat" I repeat my earlier comment. "There, he parrots what he said earlier," Lata does not miss the chance to have her sweet little verbal revenge.

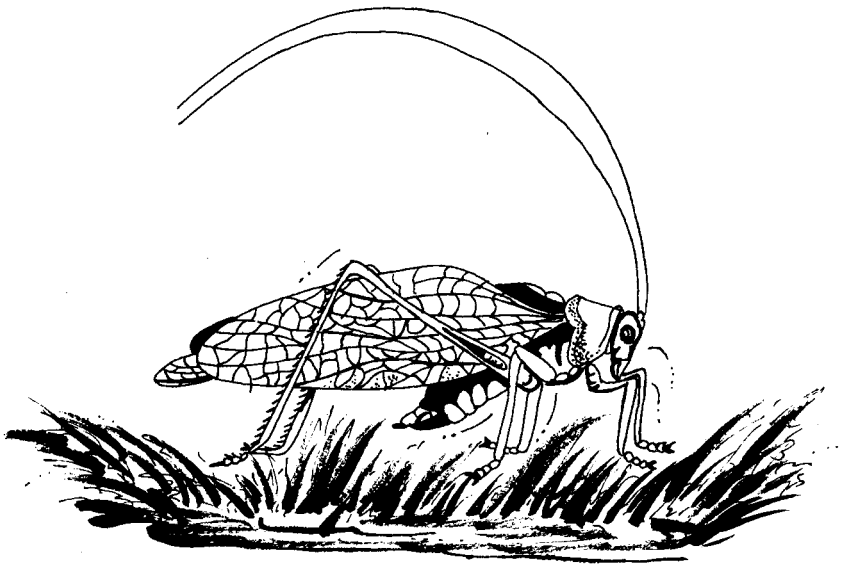
"Who is not a copycat? Even science is a copycat. It has been so all through human history. Science never shies away from taking cues from nature. Science copies what nature does. This does not happen

easily. Even now, there are many things that nature does, which science tries to find out and adopt," Nanu is all praise for nature.

"You can't be serious," I sound sure of myself. "I am, my dear Ranga. I am absolutely certain of one fact. Science owes its all to nature," Nanu stands his ground. "Good. So I can now be a copycat and my little brother can't tease me for that," Lata takes a few steps, which are close enough to those that a deer takes.

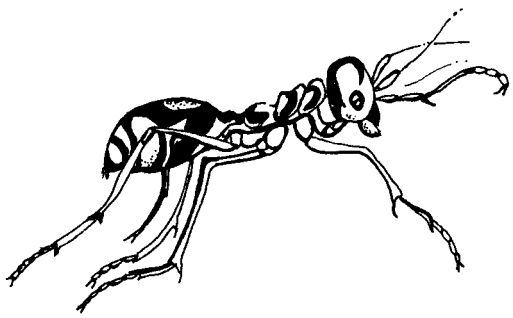
"How does science copy nature?" I ask Nanu. "Come. Let us sit in the sun. I shall tell you what I know about the tips science picks up from nature," Nanu leads us to a sunny spot on the lawn in front of our house.

We sit down on the patch of green grass. My eyes rivet on a grasshopper. It stops in its path. It moves its legs, briskly. Is it giving itself a cleaning? Is it combing its lower part? Then I find an ant. It too



A Grasshopper

moves its legs, and I think, once again, of the comb.



An ant

"I get it now, Bhaiyya. Man learnt to use the comb, after watching the grasshopper or the ant preen itself," I let a big smile touch my lips. "You are right. The comb works on the same principle. Yet there is a slight difference. The comb we use is longer and has fine teeth. That makes me think of the whale.

Its teeth are long. They are arranged in rows, with small gaps in between. Very much like the comb you or I use. The whale takes in water. A large quantity of water rushes in. With the water come fish... small fish and even tiny aquatic animals. The teeth act like a sieve. Small fish and aquatic animals get in through the gap. Bigger fishes are left out. The whale makes a meal of the small fish," Nanu looks at us to see the reaction.

"Wonderful," we react. "Nature has gifted the row of teeth, a natural comb or sieve, to the whale. Man uses this technique in many ways. We run the comb, through the hair, to set it in order. The sieve helps us separate dirt and stone in grains. Finer sieves separate the bigger granules from the small. The machine, with metallic teeth, is found in cloth mills. The machine cleans cotton. It shoves off the seeds. It makes the cotton more fluffy and hence easier to process. The large claw-shaped gadget having giant iron teeth, is attached to the tractor. The tractor moves. The claws form grooves in the field. The field is thus made ready for sowing. The fishing bar is yet another copy of the whale's teeth. It is placed in a stream or canal. It traps fish. See how man has taken the cue from nature and has suitably adapted it to serve his needs. That is how science copies the idea from nature," Nanu returns to the basic theme.

Golden Oriole

"I never thought the comb has cousins who clean cotton or prepare the ground for sowing," Lata comments. "And we would never have known that truth but for our dear cousin," I turn to Nanu with admiration.

"Thank you. Nature is with us. Always. Everywhere. Take, for instance, the cradle in which you were rocked, when you were a little baby. The idea is borrowed from nature. The idea is a take off from the golden oriole, a common yellow

bird. It prepares a pouch-shaped nest. The nest hangs from a thin yet strong and supple branch of a tree. This is called the hammock nest. With every waft of the wind, the nest rocks. Here the bird lays it eggs. The eggs hatch. The chicks find a ready-made cradle. The cradles we use is an offshoot of that. Go to any construction site. You will find babies, snugly lying in cradles made of saris or long strips of cloth.

A Kangaroo

The saris or the strips of cloth go over the branches of trees. The free ends are knotted tightly. The bottoms of the cradles are wide enough to take in the babies. The women work while the babies are rocked around in the hammocks," Nanu shows us how man has borrowed the idea from nature.

"Why do we say, 'Rock the cradle'?" Lata asks. "I don't know. But it is while in the cradle that one gets introduced to rock and roll," I joke. "Rock and roll is a form of music. It has nothing to do with lullabies. Babies like lullabies...Know the origin of the word, LULLABY. I think it is a mix of two words, LULL and BABY... Lullaby makes the baby stop crying," Lata has her comment to offer.

"Lullabies do not lull the baby kangaroo. Nor does it take to a cradle. It is happy with its mother's pouch. The mother hops around. The baby stays in the pouch. That reminds me of women who work in

Women Working in plantation

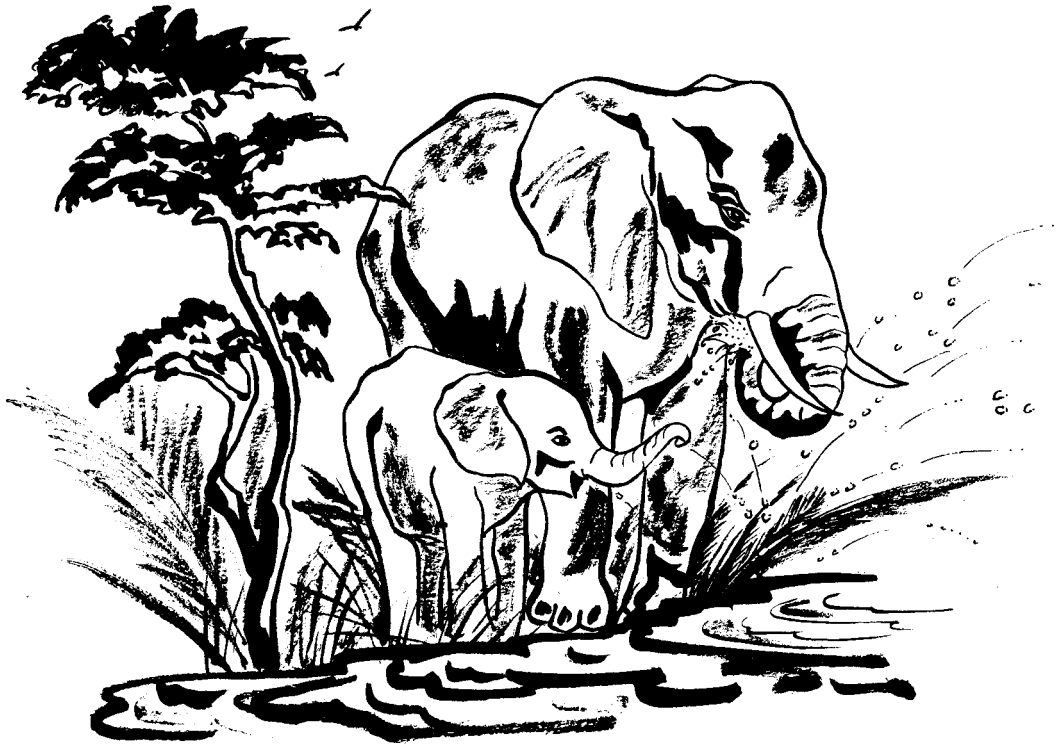
Butterfly sucking nectar out of flower

plantations. They take their babies along. Often the baby is placed in a wicker basket. The basket hangs on the back. The baby is strapped to the basket. It gets all the rocks and the rolls with every movement that the mother makes," Nanu says.

"Did not the Rani of Jhansi have the baby with her, rolled up in a strong cloth, that lay on her back, while she rode into the last battle of

her life? Is that not a fact of history?" I say. "Is it not her story? So why do you call it history?" Lata puns.

"There are many cues we get from nature. You use the fork to pick up a prune. And I am reminded of the shrike. It is a bird which makes a meal of insects. It takes its catch to a thorny bush. It presses the prey against a thorn. The insect gets pinned to the thorn. Then the bird starts its meal. The shrike does not have mobile thorns. Man took the idea of pinning down food with a fork. What is a fork? A tool with sharp thin ends; very much a collection of thorns. Man has thus improved upon the shrike and its method to pin down food," Nanu chuckles to himself, when he realises that we are lapping up every word of his with great interest.



Elephants drinking water from a stream.

"Once the fork has fed me enough, the straw comes in," I think of the bottle of soft drinks. "How does the straw work? Where did we get the idea that liquid can be driven up the straw by sucking? Did we get the cue after watching the butterfly? The butterfly has a proboscis. What is a proboscis? It is nothing but a long tube. It is a sort of duct." Nanu explains.

"So it can take nectar in," Lata comments. "It is not quite that simple. The nectar won't go up the tube on its own. The butterfly draws air in. That is what sucking is all about. The nectar moves up the proboscis. It moves all the way up to the mouth. The butterfly has its fill. The honey sucker has long tubular beaks with which it sucks honey. So the name is apt... don't you think so? There are no tell-tale marks at the end of the drinking session. The bird hops off to a new source of honey and back it goes to sucking. Have you watched the elephant? It has a long trunk. The trunk is a hollow tube. The elephant sucks in water from a stream. Then it holds the end of the trunk in its mouth and drinks. Or it squirts the water over its body," Nanu leaves no room for any further doubt. We sense that the straw is a copy of the nature's gifts to butterflies and honey suckers and elephants.

The bat never loses its sense of direction even when it flies in near darkness.

"Who is the sucker?" I ask. "Everyone is a sucker. Did not the wit say, 'A sucker is born, every second, somewhere or the other?' Every baby is a sucker, to begin with." Lata comes up with an original theme.

"Well said, my girl," Nanu pats her. "That is too soft a pat to make any impact. I can show you how to deliver a whacking pat. Once I deliver it, the victim virtually loses all sense of direction," I raise my arm, but Nanu holds me down, firmly.

"The bat never loses its sense of direction, even when it flies in near darkness. By observing this power of the bat, science has evolved a major tool. It has wide application," Nanu speaks in riddles.

"What is that tool?" I am curious. "For that, you must know how the bat gets along in darkness. Then you may get the cue. You may guess what I have in mind," Nanu wards my question off. "Come on, make it snappy," Lata has an edge to her tone.

"Bats fly around, in near darkness. Yet they never get involved in accidents. They don't crash into each other. They live in very strange places. Often they have their homes in caves. These caves let in very little light. Yet bats don't hit jagged projections in the rocky caves," Nanu pauses.

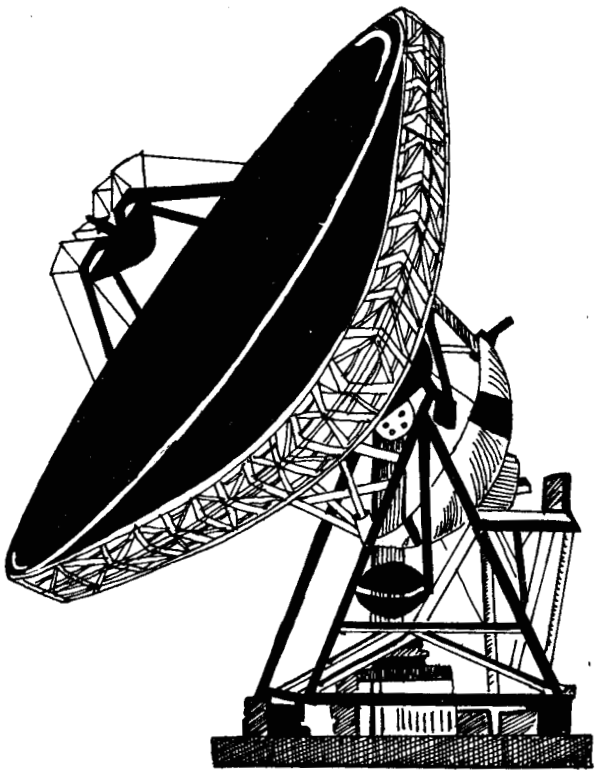
"Once I saw a performance. A circus artiste had his eyes tied with tight cloth. Then he drove the motorbike through a crowded route in Delhi. Not once did he bump into a pedestrian or a bus or a car or a scooter or a cycle," I remember a show I witnessed two years back.

"I don't know the science behind that show. But I know how bats fly in near darkness. In 1920, Professor Hartridge studied the movements of bats. He guessed that bats fly with the help of supersonic sounds. Supersonic sounds are not audible to us. The sounds spread out in waves. They bounce back from obstacles. The echoes reach the bat. The bat knows, from the strength of the echoes, where the obstacle is. And this judgement is made in very quick time. Then it adjusts its flight path," Nanu bats along merrily.

"You mean the bat can make adjustments quickly?" I can't believe it. "It can and it does. I agree that this is a continuous process. Sound waves go out as the bat flies around. Echo waves return in steady

streams. Yet the bat has enough brains to work out the right flight path," says Nanu. "That is nature's gift to the bat," says Lata. "And nature's gift, finally, to science and to man too," Nanu gives us a glance and then takes off, "You have heard of the radar?" "We have," both Lata and I respond in one voice.

"The technique which the bat uses to fly safely goes into the radar. The principle behind it is simple. What is sound? It is a burst of energy. The burst of energy bounces back, if it runs into something. The time taken to return to the starting point tells of the location of the obstacle. The radar uses energy in the form of electromagnetic waves. The range and power of radars vary. But the principle is the same. That is a principle which science learnt from the bat," Nanu asserts.



"Radar is in wide use during wars," Lata drops a bit of information. "And in peace time too. Police use radars to track down illegal flights. Or watch the borders. Radar has a cousin," Nanu stresses the last word. "May cousins flourish!" I grin.

"Do you know what I have in mind? I am talking of the sonar. It is used to spot submerged obstacles. In war time, sonar is used by naval destroyer to spot submarines. The sonar uses ordinary sound waves. The sound waves eddy through the water. When it strikes an object, the waves bounce back. The nature of the echoes indicate if the object is mobile or fixed. If it is mobile, further

readings are taken. The speed at which the object moves is assessed. That tells whether the object is a submarine. If it is, the destroyer swings into action," Nanu explains.

We hear the sound of a metallic cane, striking the cobbled footpath. We notice a man, moving his cane, now to the right, now to the left, testing the ground, taking slow steps. "I know the man is blind. He moves with the help of this cane. It is no ordinary cane. It echoes sounds," Lata says.

"Right. The cane picks up the sound. It rings bells in the ears of the man. He has learnt to read the echoes. So he knows what the echoes indicate. There is a step ahead; or a pothole in front; or a large stone in his path. He moves, without tripping and falling. The cane becomes his ears. The bat has taught us how to use sounds and echoes to help the blind," Nanu gives us an insight into the secret. "So the blind can see..." I break off, on finding Lata itching to say something. "...with the help of the ears," Lata completes my theme.

"Sound is always sound. You know what I mean. Sound has another meaning. If your argument lacks logic, it ends up as 'sound. Just sound.' Otherwise, it is truly sound. Here SOUND means RIGHT, CORRECT. When sound goes with science, it becomes logically sound. Take, for instance, the sounds which fell on the ears of Watt," Nanu drops the name.

He continues, "He was a young boy. Full of energy. One af-

ternoon, he returned home after school. He ran into the kitchen. He braked, just avoided bumping into the stool on which his mother was sitting. She turned angrily. He cooed, 'Oh Mamma.' That stilled her anger. She drew him into a warm hug," Nanu begins the narration.

"You must take to writing," Lata offers him a tip. "That is unwanted advice. Who takes advice? Nobody. Yet everyone gives advice readily," I demur.

"James Watt, then, is an exception. For he took the advice that the dancing lid gave him. He saw the kettle on the oven. Tongues of flame hugged the pot. The lid moved up and down. It made rattles. It did not fly off. It was too heavy for the steam to overthrow. The steam sought an escape. Then it found the spout of the kettle. The steam came hissing, through the spout.

"The rush of the steam and the dance of the lid were fun to watch. Then Watt got a tip. He felt right on top of the world. 'Steam has immense power,' he told himself. 'The lid dances under pressure from the steam. The snout gives way to the steam which hisses out. Can the power of the steam help man?' We all know how he developed the steam engine. "The train chugs along, powered by the steam engine. The ship sails the high seas, drawing power from the steam engine. All because Watt caught the tip from nature," Nanu completes the story. "Watt got the tip from the kettle," Lata breaks in.

"Take my advice. Keep your mouth shut. Your tongue is never at rest. Curb the tongue. Have you not heard the phrase 'Slip of the tongue' and the embarrassment it causes? Trouble awaits one who always rolls the tongue," I snap.

"The railways are known as rolling stock. What helps them roll? The wheels, of course. The wheels run on rails. The wheels face very little friction. So the train moves smoothly. The energy is put to maximum use. Invention of the wheel is a landmark in man's progress. Who got the idea? And how? I can imagine the scene. A few men of a tribe stand, on top of a hill. They have nothing to do," Nanu says.

Man rolling the stones down the hill

"They have time to kill," I intrude, repeating the idiom which Papa uses when he finds one or other of us doing nothing. "Nobody kills time. Time kills everyone," Lata has picked up that cue from grandfather.

"Why not put time to good use? Well, the men of the tribe found stones. Some were jagged. Some were smooth. Some were almost perfect spheroids. The men rolled them down the hill. The jagged stones stopped midway. The smoother stones went further. The stones,

smooth and spherical, went all the way to the valley beneath. You know why?" Nanu sets us thinking.

"Because the smooth, round stones faced little friction," Lata is

Boy skating on the road

quick to answer. "You are right, my girl. This truth struck one of the men of the tribe. He polished stones. He made spheres of them. He checked how far they moved. He tried with rounded pieces of wood. The cart moved faster when mounted on smooth even logs of wood. Others joined him. The design was improved. Finally came the wheel. It made transport easy. It helped the potter and the spinner and the miller," Nanu shows how nature helps science.

"Without wheels, I can't go skating on roads," I give credit to wheels. "Nor will the musical clock keep time and chime every hour," Lata is not left behind. "I agree," Nanu smiles. "So we have no

differences. They have been bridged," I deftly play with the word BRIDGE. "The idea of a bridge too came to man from nature. How? Back we go to early man. He could not ford big rivers. He could not get across the tumbling, rumbling mountain streams. He wished he could find a way out. One day, he was standing at the banks of a wild stream. The stream was in spate. It hit against the banks with fury. There was an old tree. Its roots were exposed. The stream tugged at the roots. The roots became lose. The tree shivered. The stream gnawed at the roots. The tree now tilted. Then it crashed. It fell forward. Its top came down with a thud, on the opposite bank. It lay inches above the flowing water.

The man came closer. He checked the tree. He tried to roll it around. He could not. The tree was firm. It ran all the way, from one bank to the other. The man got a bright idea. Why should he not walk over the tree to the opposite bank? He hesitated. He could slip. Then he would fall into the rolling waters. That would mean certain death.

It took him some time to overcome fear. He sensed the tree was strong and sturdy. He took a few steps. It was fun to watch the angry river rolling beneath his feet. He edged forward. He moved inch by inch. Then he lost all fear. He sped along the tree to the other bank. And back he raced to the starting point. There stood a few members of the tribe. They too crossed the river, back and forth. Science took the cue. Technology developed the idea. Yet it was nature which gave man the tip. The fallen tree became the first bridge. That tree deserves the kudos," Nanu turns to us.

"Three cheers to the fallen tree," Lata cries. "Hail thee, fallen tree! For you became the first natural bridge," I come in.

"The bridge helps us get across long stretches of water. Sometimes dams help us. Nature made the first dam. Do you know how? There was a quake. The mountains quivered. Big stones rolled down the slopes. They tumbled, one after the other, into the river which flowed between two hills. The stones piled up one on top of the other. More stones came down. They stood, on the shoulders of the stones

Primitive man crossing the stream

below. The stone wall rose. It stood in the way of the flowing waters. The water pushed a few stones aside. But the stones came in much faster. Soon the river lost its strength. It could not dislodge the stones. The stones formed a natural barricade. The water formed a big lake.

The quake ended. Early man came out of his caves. He trekked to the river. Then he got a surprise. The river had swelled up on one side. He saw the stone wall. Beyond the stone wall, where once the river ran wild, was just a trickle of water. He remembered the drought, an year back. The stream had dried up. The tribe suffered much. 'Now,' he told himself, 'The stream won't dry up. The water, stored by the lake, will see us through.' He ran to his people. They came with him. They went down on bent knees and thanked the gods for saving them from future droughts," Nanu recreates the scene.

"If the quake had not taken place, science would not have got the tip from nature," I react. "There you go wrong. Let me explain. Think of a tribe, living close to a creek. There are beavers around. Beavers are very active and are full of energy. They have immense strength too. Do you want to hear the story of the beaver and the early man?" Nanu rouses our interest by using the word, 'Story'. "We are always ready to hear stories," Lata and I speak together.

"This happened thousands of years ago. A small tribe lived close to a creek. A member of the tribe walked to the creek, after a heavy meal. He had time to kill. He sat at the foot of a tree and closed his eyes. He waited to take a nap. But the shrieks of beavers disturbed him. He screamed at them. But they ignored him. He watched them, with anger. Soon his anger subsided. He saw how playful the beavers were. They were having the time of their life. He lost his heart to them. The beavers dived in and out of the water. They rolled logs of wood. Where did the logs come from? The man sought the answer. He found beavers, attacking trees with their sharp teeth. They did not tire. They worked hard. Slowly a small wedge appeared on the tree. Very much like the one that the axe makes on a tree. This wedge was about a foot above the ground. The beavers now went round the tree. They started biting the tree. Soon, the tree had another wedge. The beavers contin-

ued to bite. Finally the tree crashed. The beavers chopped the tree into small logs of wood. They rolled them into the water. They guided the logs to the narrow neck of the creek. They piled the logs, neatly, in place. They filled the gaps with stones and leaves. Soon the neck of the creek was blocked. A dam had come up," says Nanu.

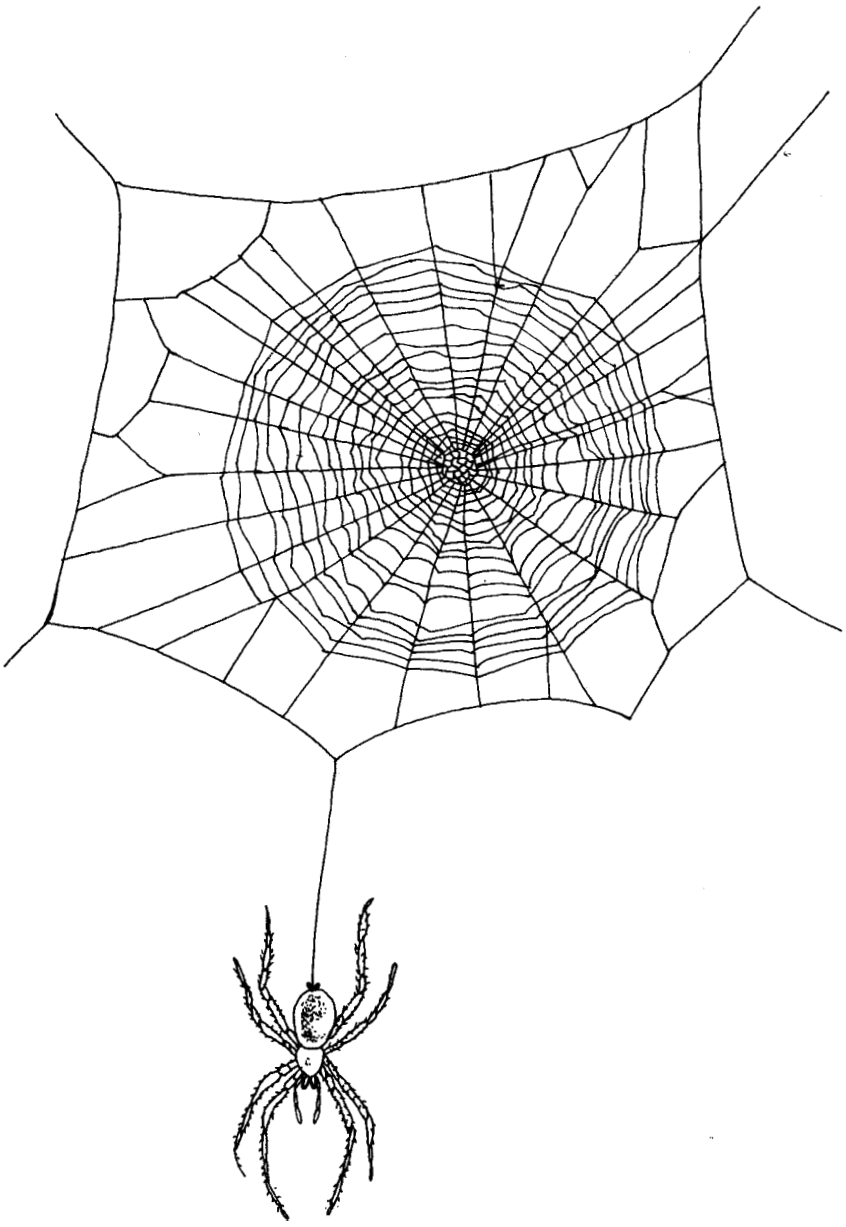
"And science got yet another cue," I share that news with Nanu and Lata. "Why don't we use beavers to build dams for us?" Lata gets a brain wave. "It is the done thing. Lata. In 1986, the Bureau of Land Reforms in south-east Wyoming, U.S., faced a problem. The meadows were becoming dry. Soil erosion turned the meadow slowly into waste-land. Grass grew only close to the creek. Not on the vast wide meadows. Where lay the answer? Officials decided to build a concrete dam. Bruce Smith, a biologist, did not agree. 'That will be costly. Why can't we use local material. And use almost free labour?' he asked.

The officials were taken aback. What was in Smith's mind? They asked him to explain. He smiled. 'I will show you how it can be done,' he said. "He cut some timber. He piled the logs close to the stream. He noticed the beavers which kept an eye on what he was doing. 'Boys, you shall do the rest of the work,' he waved his hand to the beavers. He moved back. The beavers swung into action. They rolled the logs, one by one into the stream. The gaps were closed with small pebbles or with mud. In a few days, the dam was in place. That was a major success. The meadow regained its fertility. The area began to thrive with greenery. Erosion stopped. The stream once flowed through sandy strips. Now thick vegetation marks the entire route along Sage Creek in south-west Wyoming. The beavers built the dam. For almost free. They carry out annual maintenance too. All that the Bureau officials do is to stack timber. The beavers do the rest," Nanu's story is fantastic.

"No social activist, I hope, will fight for the beavers and ask us to stop exploiting them," Lata jokes. "We are not exploiting the beavers. They have fun building such dams," Nanu points out. "Are these dams strong?" I inquire. "They are," Nanu's eyes suddenly sparkle.

"When eyes sparkle, I get a message that you have remembered

something very interesting," Lata puffs up her cheeks with pride at her detective skill. "What is strength? Does it depend on the object's stretchability? What do you think of the spider's web? Is it strong?" Nanu asks. "I push my finger through and the web winds itself on my finger. Who says it is strong?" I assert.



"Yet there is no fibre, which is thinner and still has more stretching power than the spider's web. That is where its strength lies. It took man long to realise this. Now science has got the message. The finest of bullet-proof vests will adopt this technique," says Nanu.

"Impossible," I hiss. "For once, Ranga is right," Lata snorts. "Poor dears! If only you hear me out! What do you think of the bullet-proof vest?" Nanu asks. "The vest makes one look fat. Rounded up. The person, if he is already fat, looks like a bloated globe," I race along with my description of the person who gets into a bullet-proof vest. "You have a sense of humour," Nanu compliments me. "Thank you," I politely accept the compliment. "He spins top yarns. He stretches them with skill," Lata sneers.

"So you have something of the spider in you. Most bullet-proof vests are made from a Dupont fibre, called Kevlar. It can elongate up to four per cent before it snaps. That is where the spider's web scores. Stretch it. It stays intact. It stretches up to 15 per cent. What lies behind this strength? Scientists don't know. They are determined to find out the secret. They think it lies in some chemical in the web. They are excited by the chase," Nanu pauses.

"There is a hunter in every man," I take the chance to make that comment. "That is there in every human being," Lata corrects me. "The scientists are out on the hunt. They will not give up till they find the secret. Then will come sleeker bullet-proof vests. The new vests will cheer the VIPs. No longer will they look like bloated balloons," Nanu finds us rocking with laughter and joins us.

"Balloons fly away," Lata draws attention on the nature of balloon. "Ballooning is yet another field where science imitated nature," says Nanu. "Is there a story in it too?" my voice quivers with excitement.

"Yes. Early man saw the birds in flight. He wished he too could fly. Poets gave wings to this desire. For example, *Sage Valmiki,* known as *Aadi Kavi*, talks of *Pushpaka*. We can think of it as an aircraft. There is the story of Icarus. He made wings out of wax. He attached

them to his arms. He flew out. He rose higher and higher. He told himself, 'I will fly to the sun.' The heat mounted. Icarus did not give up. He flapped his hands, very much like a bird. He felt the drag. He was not making much progress. Why? He checked his wings. Then he got the fright of his life. The wings were melting away, under the heat.

Soon Icarus had no wings. Gravity was waiting for just this chance. It dragged Icarus down. He fell, slowly at first, then faster. He hit the ground, with a thud," Nanu regales us with two tales which tell of man's desire to fly into space.

"Icarus would have reached the sun, if he had heat-proof wings," I suggest. "The wings would have reached the sun, not Icarus. He would have been turned to ashes," Lata finds the flaw in my claim. "Ashes and smoke are end products of burning," Nanu remarks. "Ashes always remind me of the prize that awaits the winning cricket team," I hint that the word ASHES has yet another meaning. "Tell us the story," Lata nudges Nanu.

"Ashes and smoke go well with fire. Smoke moves up. It takes with it light objects, like burnt or charred paper. On a cold night, two young men, whose father was a paper merchant of France, lit the logs in the fireplace. They sat around the fireplace. The room warmed up. The smoke curled along the chimney. Some bits of burnt paper too moved up, went with the smoke through the chimney. The brothers noticed it. What made the charred sheets fly? Did hot smoke have that power? They decided to try. They made a big balloon with strips of cloth and gum. They carried it to the wide open ground in the town. Ropes went around it. The ropes were tied to stakes, driven into the ground. The brothers lit a fire. The smoke started curling up. The mouth of the balloon was held against the smoke. The smoke ran in to the balloon.

"The balloon filled up with hot air. It swelled. It rose like *Kumbhakarna* after six months of sleep," Nanu drops a reference from the *Ramayana*. "If a competition were held between *Kumbhakarna* and Rip Wan Winkle? If the prize were to go to the one who has a record for non-stop sleeping? Then?" I leave the question for Lata to pick up. "Rip Wan Winkle walks away with the prize, leaving *Kumbhakarna* far behind," Lata has the answer.

"The balloon now rippled with strength. It tugged at the ropes. The wind ran over it. It groaned. It whined. It made all sorts of angry snorts," Nanu says. "When someone or something makes snorts,/ it's clear, patience is running short," Lata spins a couplet. "That's the short and long of it," I fill in. "The brothers beamed big smiles at the

crowd that had gathered to watch the tamasha," Nanu says. "What draws a crowd to such shows? Curiosity," I comment. "Curiosity, by itself, is not enough. One must have time too," Lata offers a tip.

"So you think those who form a crowd are curious and idle?" Nanu combines our statements to arrive at a truth. "You said it," Lata and I agree with him. "What the crowd saw was a giant droplet? You know what a droplet is?' Nanu pauses. "Why don't you explain?" we bounce the question back at him.

"It's simple. You too can turn out a droplet. Hold a bottle of liquid. Drill a small hole in the lid. Invert the bottle. One drop of the liquid cheekily pops out. It tries to cling to the lid. Gravity pulls it. The

droplet loses its hold. It falls through space. It looks like a balloon," Nanu describes. "The balloon, therefore, is a droplet, filled with hot air," I define.

"That is true of the balloon which stood at the square of the French town, that day. The brothers sewed up the neck of the balloon. The hot air was now imprisoned. It pressed upwards. It wanted to escape," Nanu says. "Who likes to be imprisoned?" Lata remarks. "The brothers untied the knots of the ropes which held the balloon down. The balloon quivered. It looked hesitant. It rose, slowly, at first. Then it flew for some distance. The brothers were thrilled. They had done it. The crowd cheered. The brothers bowed. They had taken the cue from nature. Hot air lifts things up. That is the science behind hot-air ballooning," Nanu completes the tale.

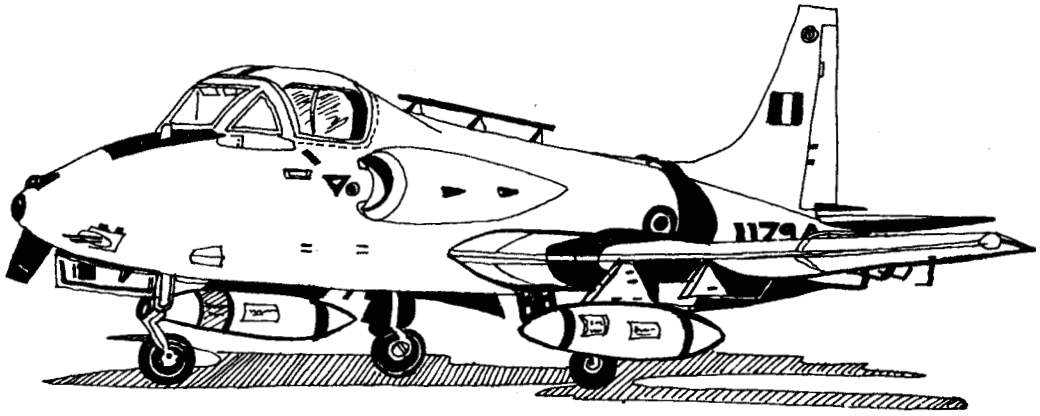
"Did they break balloons, as we do while celebrating grand occasions?" Lata wants to know. "I don't know. I did not witness the event," Nanu dodges. "Why do you dodge? Better, you duck./ For the master of the dodge is the duck," Lata has yet another couplet.

"You may duck and dodge, but what goes up usually comes down. That reminds me of the cotton seed. It breaks away from the plant. It takes to flight.The fluffy roll... white and light... swings with the wind. It moves up, comes down, taking dips and turns, performing somersaults in the air. Finally, having enjoyed its heady flight, the seed, with its coat of light fluffy cotton, comes down to the earth. The seed puts in roots. Soon a tiny sapling of a cotton tree pops its tiny head out into the sun," Nanu enjoys the recital. "What cue does the flight of the cotton seed offer us?" I inquire.

"The cotton seed flies, even though the seed is heavy. The fluffy cotton jacket of the seed fights gravity. The air provides the upward thrust. The cotton seed moves far away from the mother tree. So it gets room to put in roots and grow. The flight of the seed brings a message. A heavy object can still stay up in the air, if it has a protective coat. Something that can use air pressure to fight gravity. We adopted it, developed the parachute," Nanu points out yet another trick of nature.

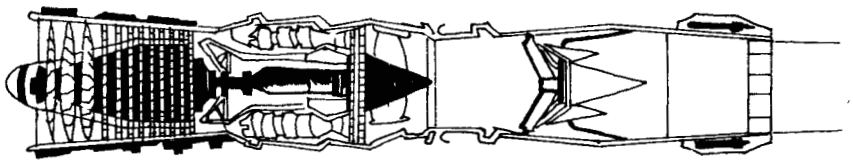
"One day, I will go para-diving," I share my dream with Nanu and Lata. "I hope you come down in one piece," Lata scowls. "We are getting truths about nature's tips in bits and pieces. Take aircraft, for example. Nature has been taking heavy object into flight. The cyclone, for example, has immense power. It uproots trees. It flies away with roofs of houses. It picks up heavy objects. One freak cyclone hit Delhi, about two decades back. It took the form of a funnel. Anything that came in its wake got air-lifted. When the fury ended, everyone sighed in relief. A scooterist, who narrowly escaped death, found his vehicle missing. He searched. Finally he found it on the terrace of a house nearby. Where did the power come from?" Nanu asks. "You tell us," Lata and I turn to Nanu.

"Air has pressure. Bernoulli studied air pressure. Then came a tip. An object, with a flat base and a curved top, travels longer distance in air. Why? Because the air travels along the flat base. It covers lesser



distance. So the air pressure is higher. The air travels, in the same time, longer distance while going over the curved top. So the air pressure is lower. The difference in the air pressure holds up the object in flight. Look at the wing of an aircraft. The bottom of the wing is flat. The top is curved. So the aircraft gets upward thrust. The motor gives the forward thrust," Nanu makes the complex idea clear to us.

"You will say that nature gave us the tip for the jet engine," I joke. "It did. The jet engine makes full use of air power. It sucks in air. It forces the air to rush out through narrow nozzles. The air goes back



Jet Engine

with tremendous force. Newton told us that action and reaction are equal and opposite. The air rushes back. That is the action. What is the reaction? The aircraft moves forward. Want to try it? Get hold of a small balloon. Inflate it. Clamp the neck with your fingers. Then take off the fingers quickly. The balloon moves in all directions. It flies aimlessly. It shrinks, as the air rushes out. What powers the flight?.... The rush of air," Nanu indicates the fun we can have with balloons.

"Air does wonders. We force air into the *harmonium* or the piano and get lovely musical notes," Lata says. "Or ear-splitting notes which lack *taal* and *swar,*" I snipe.

"Nature has been producing music, since eternity. Go to the grove. Trees dance in the wind. The branches brush against each other. And nature sings lovely tunes. Air goes through hollow bamboo stumps and often produces lilting notes. It took man a long long time to master the art. Slowly he gained knowledge. It began with flutes and lutes. Then came the windpipe and the *nadaswaram* and the *shehnai*, the piano and the *harmonium,*" Nanu tells us how nature has been using air to produce music.

" Thus came Doe Ray Me,/ In the West, to show music the way;/ While, in the East, we,/ With Sa Ri Ga Ma, have our musical say," Lata produces the basic notes. "No verse can be that worse. In my view, your verses are uniformly rank bad," I criticise her.

"Have you seen the jungle uniform of the soldier?" Nanu asks. "A mix up of green and pale yellow and grey and fading brown," I am quick to answer.

"Right. The jungle has a mix of all these colours. So the soldier fits in well. He becomes part of the jungle. And if he doesn't move, nobody will notice him among the trees and the shrubs and the creepers. That is known as camouflaging. Is that a big word?" Nanu gets a doubt.

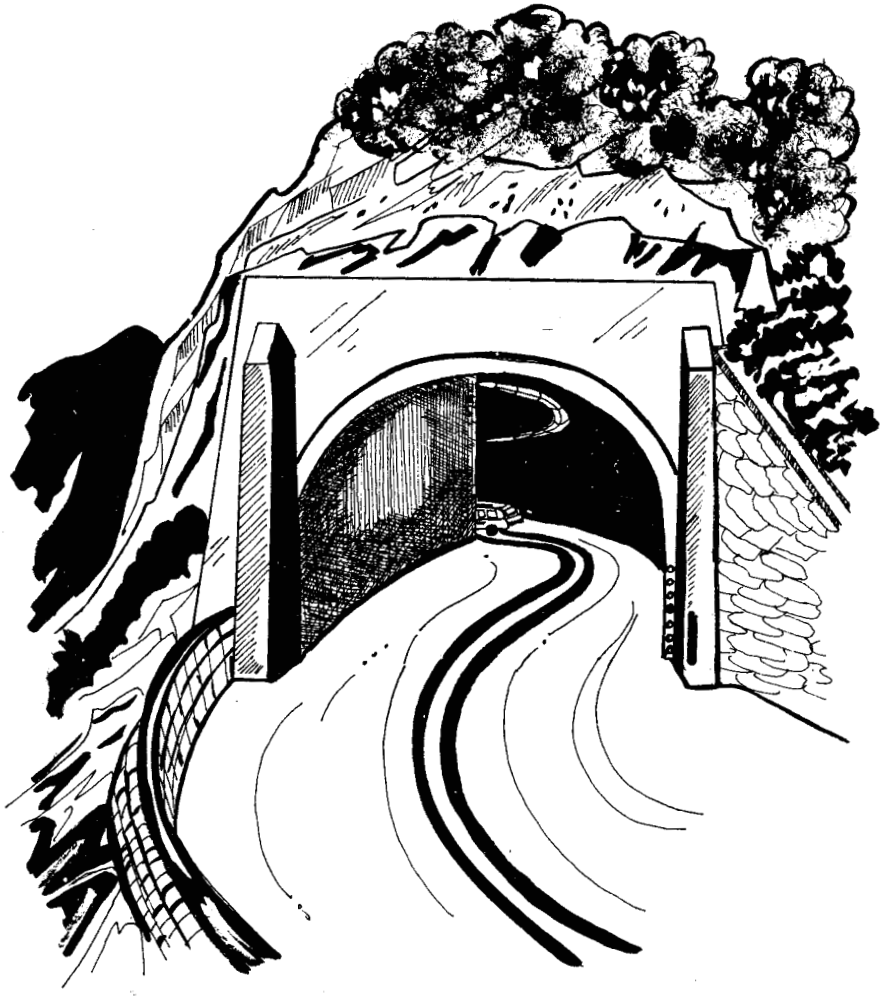
"No. We know that word. It stands for deception. The chameleon does that. It sticks to a green leaf and turns green. It runs on to a rough grey bark of a tree and becomes grey all over. Thus it escapes attention of birds which enjoy a meal of chameleons," Nanu points out.

"A person who changes colours is also a chameleon," Lata finds scope for intruding. "So, when you change from a green frock to a pink pant, you are doing a chameleon," I carp.

"When it comes to taking digs at each other, the two of you are perhaps the world's best. The best dig in recent times is the one that went below the chalk lining of the British Channel. You now have trains running from France to England through the Channel Tunnel," Nanu shares the news with us. "I know. Is it not called the Chunnel?" I ask.

"Yes. Tunnels cut through hills; go under river beds; drill their way under straits and channels. Where did we learn the art of making tunnels? From nature, beyond doubt. The mountain stream makes tunnels under rocks and ice sheets. The mole, the field mouse and the bandicoot make networks of tunnels. The earthworm eats its way through to make tunnels. Man learnt the art of making tunnels from these lowly creatures," Nanu provides the background.

"Trains go through tunnels. Buses roar through tunnels. It is fun going through tunnels. The engineers who drilled the tunnels learnt the art from the mole, the earthworm..." I pause. "Where did they learn it from? From nature, for sure," Lata stresses the obvious.



A Tunnel

"Nature is the best teacher. Take the woodpecker, for example. It pecks at every tree," Nanu checks whether we are attentive.

"Why?" I ask. "Don't you know the simple fact/ That the woodpecker is the drummer of the forest;/ And it beats the drums, as per contract,/ So it gets its wage in the form of worms at rest?" Lata is in a really creative mood and has a verse to suit every occasion.

"You said it. The woodpecker hugs a tree. Its claws help it get a firm grip. Its neck curves back. The beaks stand about a foot from the bark of the tree. Then the bird goes into action. The sharp beaks, held

A Woodpecker

together, ram into the bark. The beaks draw back. The bark shows a dent. The bird draws back its neck. Once again, it strikes the spot with a hard blow. This goes on. The knocks produce sounds. Lata thinks they are drum beats," Nanu finds Lata squirming and peers at her.

"When the woodpecker beats its drum, the little insects and worms, resting in the tree, get the message that the enemy is around. They have no defence. The tree is a fort. The fort is under siege. The worms shiver with fear. The drum beats get closer. The worms don't know where to go. They draw back, as far as they can. Then they bump into the hard core of the tree. The beaks grab a worm. The worm wriggles. And then it is gone. The beaks come, again and again, till the bird has its belly full," Lata details the scene.

"That is the end of the worms and the insects. Early man watched the woodpecker. He learnt to drill holes or to chisel shapes after watching the woodpecker at work. He shaped many tools after the sharp long beaks of the woodpecker. He saw how the woodpecker worked. It draws its neck back. It brings its beaks down on the chosen spot with power. Very much like the hammer that drives nails in," Nanu explains. "That is so," Lata agrees.

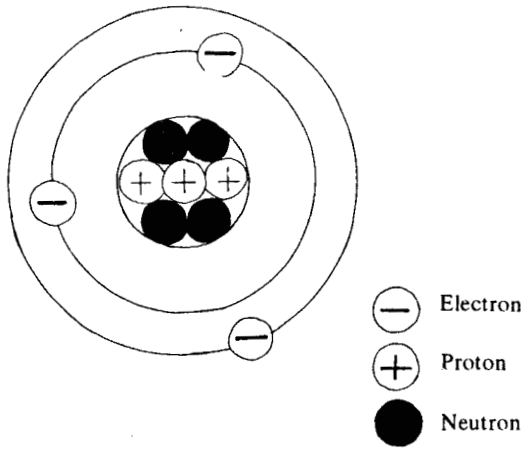
"Don't we act like the woodpecker when we drill for oil? Geologists analyse the soil. They study the terrain. They feel there is oil deep within. That makes them swing into action. Tools to drill are brought to the site. The drills go after the oil, very much like the woodpecker,"

Nanu says. "The oil is the worm, now," I find a comparison.

"Like the worm, the oil snuggles in the core of the earth. It lies under layers of rock and sand and mud and clay. The drill goes deeper. And still deeper. At last it dips into the oil well. The oil still thinks it is safe. Not for long. For man has learnt from nature, how air current operates. Air knows how to exert pressure. Man knows how to make air work for him. He sends a waft of strong air down along a pipe. The air comes at terrific speed, down a pipe that reaches up to the oil well. The air pushes the oil towards the drill. The oil resists. But not for long. Then the oil runs up the drill. The air creates a siphon. Oil rushes out with tremendous power. Thus we get the fuel to meet our energy needs," says Nanu.

"Is energy not there in the atom?" Lata makes a reference to atomic energy. "There is. Yet, we did not know of its power, till recently. Nature held this secret from us. Early man had some idea. He spoke of alchemy. Do you know that word?" Nanu checks with us. "Alchemists claim they can change an element into another element," Lata answers. "They have the Midas touch," I add, remembering the story of King Midas. He could turn anything he touched into gold.

"In 1803, John Dalton started the hunt. He hunted out the truth about elements. Every element, he said, is made up of atoms. The atom of each element has a different weight. He added that the atom is indivisible. Everyone agreed.



An Atom

Dalton's theory stayed for about hundred years. Then came Ernest Rutherford. He studied the atom. He found more details about the structure of the atom. Then he found a similarity of the atom's structure with the solar universe," Nanu wonders whether we understand him.

"The planets go round the sun," I comment. "The sun stays put," Lata adds. "Right. The atom too has a sun. This sun is the nucleus. It is a positive charge of electricity. Around it whirl electrons, which are negatively charged. Each atom is thus a pack of energy. But man still did not know how to break the atom. Albert Einstein provided the key. He found a relation between mass, energy and speed of light," Nanu pauses.

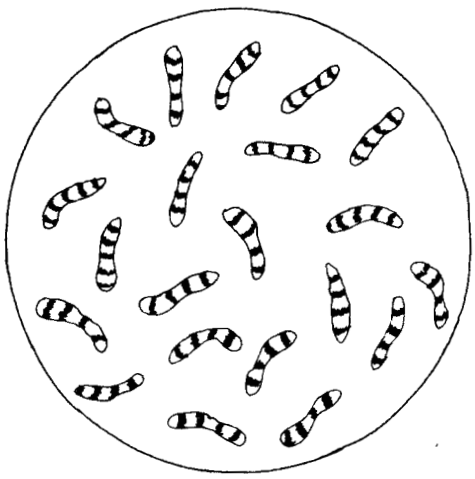
"I read a formula, E equals the product of mass and the square of the speed of light. (E= M x C x C)," I point out.

"Right. This helped scientists split the atom and release energy. Now nuclear energy lights up streets, at night; runs trains; flies aircraft and ships. Why did it take us so long to get the cue about the energy in the atom?" Nanu raises a question. "Because nature does not use atomic energy," I have the answer. "There you go wrong. What do think of the sun?" Nanu waits for my reply. "It is the source of all energy," I tell him.

"Where does this energy come from? From atoms. The sun is a great nuclear reactor. The hydrogen in the sun is converted into helium. This is an atomic change. Immense energy is released. The sun has been there before man arrived on this planet. It is powered by atomic energy. Nature has been working the great nuclear plant, the sun. Yet only recently we learnt the secret," Nanu pouts his lips. "Better late than never," Lata coos.

"Nature holds many secrets. Take for example the gun and the pistol and the rifle. Do you know of the humble witch-hazel shrub? It shoots out its pods, when they are fully developed. The seeds get widely dispersed. The plants do not get crowded in. They get enough room to grow and prosper," Nanu spots yet another fact of nature.

"Did nature give us the armour too?" Lata wants to know. "I think so. Does not the armour remind us of the armadillo or the turtle?" Nanu fires a question. "Lowly creatures, they," Lata snorts. "The lowliest of life form is the bacteria, the microbe," I flaunt my knowledge.



Bacteria as seen under a microscope

"Bacteria hold immense power. They are here, there and everywhere. Some are friendly. Some are hostile. Nature knows all about them. Bacteria are always at work. They do the task assigned to them by nature. John Pirt, a London scientist, tells us of a kind of bacteria. It is found in the dung of horse. This bacteria enjoys sludge. Pirt thinks we can use the bacteria to clean the sewage," Nanu says. "How easy that sounds," I go ga ga over the idea.

"Dr Chakravarty, an Indian scientist, working in the United States found a bacteria which enjoys a meal of oil slick. You know what an oil slick is. Often tankers carrying petroleum products run into trouble. The oil spills out into the sea. It pollutes the waters. Birds and fish die in thousands. If Dr Chakravarty's bacteria are around, the oil slick is quickly eaten up. So there is very little damage to ecology," Nanu gives one more example. "Wonderful," Lata claps her hands.

"Dr Ammon Peck, of Florida University, has identified a bacteria. It loves to gobble kidney stones. Many people suffer from stones in the kidney. The bacteria holds out an easy cure," Nanu takes me by surprise.

"Small is beautiful," I repeat the cliche I learnt from Schumacher. "Small is powerful, too," Lata remembers the atom. "Nature is the source of all knowledge. From the University of Auckland comes a

new lesson learnt by man from the mussel" Nanu starts off.

"The mussel is all shell and flesh. It has no muscle to talk of," Lata throws some light on the nature of the mussel. "The mussel lives in water. It has a coat made of shell," I continue.

"Nature has gifted to the mussel a chemical compound. This chemical relieves severe pain which people suffer from arthritis," Nanu tells us yet another lesson that man has learnt recently from nature.

"So we learn from the worms and the insects, the microbes and the bacteria, from the stars and the sun, from the animals and the birds, from the plants and trees," I list out the knowledge I have gained.

Plant life teaches us many things . . . how to break carbon-di-oxide into carbon and oxygen.

"Yes. Plant life teaches us many things... how to break carbon-di-oxide into carbon and oxygen. The plants release the oxygen into the air. Thus the air gets charged with oxygen. The carbon turns into carbohydrates. They become fruits and nuts and edible roots," Nanu describes the lessons trees, which are part of nature, teach us.

The sound of the blare of the horn ends our session. We turn and find Papa driving the car in, heading for the garage. We wait. Papa parks the car and joins us. He spots Nanu and asks, "When did you come?" "In the afternoon. How are you, Uncle?" Nanu politely replies.

We walk toward the verandah. I spot a bee, circling a bed of flowers, and tell Papa, "Papa, do you think man learnt to build high-rise building after watching the beehive?" Papa frowns. Nanu steps in, "My fault, Uncle. I told them that all that man knows are lessons nature teaches him." "So the scientist is here on a mission," Papa jokes.

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